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original document : P:\3430\0149P\084G1DRAFT.DOC

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Deletions appear as Overstrike text

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## APPARATUS FOR AND METHOD OF ETCHING AND CLEANING OBJECTS

### ~~Background of the invention~~ BACKGROUND OF THE INVENTION

#### Field of the invention

#### Invention

**[0001]** The present invention relates to an etching and cleaning apparatus and method for objects, and more particularly, to an apparatus and method for batch processes for objects such as a semiconductor wafer or a liquid crystal display (LCD) substrate.

#### Description of Related Art

**[0002]** Etching technology is very important for compact and complicated substrates and. Etching is followed by a cleaning process.

**[0003]** For a wet etching process a batch type process is usually adopted since it can provide mass production and a low production cost.

**[0004]** Fig. 1 schematically shows an etching apparatus of a batch type according to a conventional art.

**[0005]** A vessel 10 containing substrates 12 has upper and lower openings 111 and 113 and is linked by many pipes. To the upper opening 111 are linked a first supplying pipe 10a and a first draining pipe 10d and to the lower opening 113 are linked a second supplying pipe 10b, a third supplying pipe 10c and a second draining pipe 10e. The first supplying pipe 10a is for supplying IPA (~~isopropyl~~(isopropyl) alcohol), the second supplying pipe 10b for supplying etching solution, and the third supplying pipe 10c for supplying D.I. (deionized) water. The first draining pipe 10d is for draining etching solution and D.I. water, and the second draining pipe 10e is for draining IPA and D.I. water.

**[0006]** The etching process and rinsing process using the apparatus is explained. First,

through the second and the third supplying pipes 10b and 10c, etching solution and D.I. water are supplied to the vessel 10 containing substrates 12, respectively. In some conditions only etching solution can be supplied, since D.I. water is for diluting the etching solution at this time.

**[0007]** Next, the substrates 12 are etched by the etching solution for some time.

**[0008]** Next, D.I. water is supplied through the third supplying pipe 10c so as to ~~pull~~ **push** the mixture of etching solution and D.I. water to the upper opening 111 for draining through the first draining pipe 10d. At this time D.I. water cleans the substrates 12.

**[0009]** Finally, D.I. water is drained through the second draining pipe 10e and IPA is supplied to the vessel 10 in order to dry the substrates 12.

~~By the way~~**[0010]** However, referring to Fig. 2, during draining, the etching solution densities of the etching solution differ depending on the location of the interface of the etching solution and the D.I. water for cleaning. That is, in a certain instant during that process the density is high at the upper portion 12a of the vessel 10 and low at the middle portion 12b of the vessel, whereas at the lower portion 12c of the vessel 10 cleaning water such as D.I. water is filled. This density difference results in non-uniform etching of the substrate 12 depending on the position of the substrate 12.

~~And during~~**[0011]** During that time, while etching solution of high density is mixed with D.I. water for cleaning, an abnormal reaction such as an electric reaction occurs. When two metal layers on the substrate are etched ~~at~~ in one process, some metals such as aluminum lose their electrons and some metals such as titanium ~~get~~ receive the electrons. Donor metal is over etched, and the donee metal is less etched less, which deteriorates the quality of etching.

### SUMMARY OF THE INVENTION

**[0012]** To overcome the problems described above preferred embodiments of the present invention provide an apparatus for and a method of etching and cleaning objects which can achieve uniform etching.

**[0013]** A preferred embodiment of the present invention provides an apparatus for etching and cleaning objects, including: a vessel having a an upper opening and a lower opening; a first supplying pipe connected to the upper opening of the vessel, the first supplying pipe supplying dry gas; a second supplying pipe connected to the lower opening of the vessel, the second supplying pipe supplying etching solution; a third supplying pipe connected to the lower opening of the vessel, the third supplying pipe supplying cleaning solution; a first draining pipe connected to the upper opening of the vessel, the first draining pipe draining the cleaning solution; and a second draining pipe connected to the lower opening of the vessel, the second draining pipe draining the etching solution and the dry gas.

**[0014]** It is preferred that the second draining pipe is directly and straightly connected to the lower opening of the vessel and has ~~an a~~ **a larger** inner diameter ~~bigger~~ than other pipes.

**[0015]** It is also preferred that in the second draining pipe a pump for draining etching solution is ~~equipped~~.

**installed.**

**[0016]** According to another aspect of the invention, the method of etching and cleaning objects contained in a vessel, ~~including~~ **includes**: etching the objects by providing etching solution into the vessel; ~~exiting~~ **forcing out** the etching solution from the vessel by providing pressurized gas into the vessel; cleaning the objects by providing cleaning solution into the vessel; and draining the cleaning solution from the vessel.

[0017] Draining the cleaning solution and ~~existing~~ **forcing out** etching solution are processed through different draining pipes connected to the vessel.

[0018] The pressurized gas is preferably nitrogen gas.

[0019] The etching solution is preferably Oxalic acid solution or diluted Oxalic acid solution.

[0020] The cleaning solution is preferably deionized water.

~~Existing~~[0021] **Forcing out** the etching solution is preferably done ~~with~~ **while** pumping the etching solution out of the vessel.

[0022] The method may further include drying the objects by providing ~~dry~~ **drying** gas into the vessel after draining the cleaning solution. The ~~dry~~ **drying** gas may include IPA.

[0023] Advantages of the present invention will become more apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

[0024] For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which like reference numerals denote like parts, and in which:

[0025] Fig. 1 is a schematic view of an apparatus for etching and cleaning objects according to a conventional art;

[0026] Fig. 2 is a similar view to Fig. 1, illustrating density difference in the vessel

during the cleaning process while using the apparatus of Fig. 1; and

**[0027]** Fig. 3 is a schematic view of an apparatus for etching and cleaning objects according to an embodiment of the invention.

### **DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS**

**[0028]** Reference will now be made in detail to preferred embodiments of the present invention, example of which is illustrated in the accompanying drawings.

**[0029]** A preferred embodiment of the present invention relates to a batch type apparatus for etching and cleaning the objects such as semiconductor wafers or substrates for LCDs.

**[0030]** The apparatus shown in Fig. 3 has a vessel 10 having upper and lower openings 110 and 112, which are connected to various pipes. The pipes connected to the upper opening 110 are a first supplying pipe 10a and a first draining pipe 10d, and the pipes connected to the lower opening 112 are second and third supplying pipes 10b and 10c and a second draining pipe 20. Though not illustrated in the drawings, there are valves in the pipes for selectively closing the pipes.

**[0031]** The first supplying pipe 10a is directly connected to the upper opening 110 of the vessel 10, and the first draining pipe 10d branches off from the main passage from the upper opening 110. The second draining pipe 20 is preferably straightly connected to the lower opening 112 of the vessel 10, and the second and third supplying pipes 10b and 10c branch off from the main passage from the lower opening 112 of the vessel 10. Since the second draining pipe 20 is straightly connected to the lower opening 112 of the vessel 10, draining through the second draining pipe 20 can be done without any ~~bottleneck~~ **bottleneck**. The second draining pipe 20 can have an **larger** inner diameter ~~bigger~~ than ~~these~~ **inner diameters** of other pipes, and have a pump "P" in order to ~~help~~ **facilitate** easy

draining.

[0032] Through the first supplying pipe 10a, pressurized gas and ~~dry~~ **drying** gas are supplied to the vessel 10. The pressurized gas needs to have a relatively low solubility to the etching solution and can be nitrogen gas. For ~~dry gas~~ IPA(~~isoprophyl~~ **drying gas, IPA (isopropyl** alcohol) can be used, ~~for dry process it has a gaseous phase having temperature of about 125???.Through.~~ **Through** the second supplying pipe 10b, ~~an~~ etching solution such as oxalic acid is supplied to the vessel 10. Through the third supplying pipe 10c, cleaning solution such as deionized water is supplied to the vessel 10.

[0033] The etching and cleaning process using the apparatus of the embodiment is explained.

[0034] First, through the second supplying pipe 10b etching solution is supplied to the vessel 10 having objects 12. At this time, in order to dilute the etching solution, cleaning solution such as D.I. water can be supplied to the vessel 10 at the same time.

[0035] Next, the objects are ~~introduced under the etching process by~~ **exposed to** the etching solution for a determined **amount of** time.

[0036] Next, through the first supplying pipe 10a, pressurized gases such as nitrogen gas is ~~are~~ pushed into the vessel in order to drain or ~~exit~~ **force out** the etching solution or the etching solution mixed with the diluting solution through the second draining pipe 20. At this time, the second draining pipe 20 is open and the pump "P" is operated for easy draining. The pressurized gas is preferably chosen from ~~the a group consist~~ **consisting** of gases which ~~does~~ **do** not react with the etching solution.

[0037] Next, the cleaning solution, for example D.I. water, is supplied into the vessel 10 through the third supplying pipe 10c in order to clean the objects, and **then** drained through the first draining pipe 10d.

**[0038]** Next, for ~~dry~~ **the drying** process, IPA gas is supplied through the first supplying pipe 10a and drained through the second draining pipe 20.

**[0039]** According to the embodiment of the invention, since the cleaning solution and the etching solution ~~does~~ **do** not ~~make~~ **form** any interface during ~~existing~~ **forcing out of** the etching solution, there is no density difference of the etching solution ~~through-out~~ **applied to** the objects during the process, which ~~also leads~~ **results in** no electrical reaction during the process, leading to uniform etching for objects.



----- REVISION LIST -----

The bracketed numbers refer to the Page and Paragraph for the start of the paragraph in both the old and the new documents.

[1:2 1:2] Changed	"Background ... invention" to "BACKGROUND ...
INVENTION"	
[1:3 1:3] Changed	"the invention" to "the Invention"
[1:3 1:4] Changed	"invention
" to "[0001] "	
[1:4 1:4] Changed	"to etching" to "to an etching"
[1:4 1:4] Changed	"to apparatus" to "to an apparatus"
[1:6 1:6] Changed	"Etching" to "[0002] Etching"
[1:6 1:6] Changed	"substrates and is" to "substrates. Etching is"
[1:7 1:7] Changed	"For " to "[0003] For a"
[1:7 1:7] Changed	"type is" to "type process is"
[1:7 1:7] Changed	"and low" to "and a low"
[1:8 1:8] Changed	"Fig." to "[0004] Fig."
[1:8 1:8] Changed	"of batch" to "of a batch"
[1:9 1:9] Changed	"A vessel" to "[0005] A vessel"
[1:9 1:9] Changed	"(isoprophyl " to "(isopropyl "
[1:10 1:10] Changed	"The" to "[0006] The"
[1:11 1:11] Changed	"Next," to "[0007] Next,"
[1:12 1:12] Changed	"Next," to "[0008] Next,"
[1:12 1:12] Changed	"pull " to "push "
[1:13 1:13] Changed	"Finally," to "[0009] Finally,"
[1:14 1:14] Changed	"By the way" to "[0010] However"
[1:14 1:14] Changed	"draining the" to "draining, the"
[1:15 1:15] Changed	"And during " to "[0011] During "
[1:15 1:15] Changed	"as electric" to "as an electric"
[1:15 1:15] Changed	"etched at one" to "etched in one"
[1:15 1:15] Changed	"get " to "receive "
[1:15 1:15] Changed	"donee is less etched," to "donee metal is etched less,"
[1:17 2:2] Changed	"To" to "[0012] To"
[1:18 2:3] Changed	"A" to "[0013] A"
[1:18 2:3] Changed	"having a upper" to "having an upper"
[1:19 2:4] Changed	"It" to "[0014] It"
[1:19 2:4] Changed	"has an inner ... bigger than" to "has a larger ... diameter
than"	
[1:20 2:5] Changed	"It" to "[0015] It"
[1:20 2:5] Changed	"is equipped." to "is installed. "
[1:20 2:6] Changed	"equipped.
" to "[0016] "	
[1:21 2:6] Changed	"including" to "includes"
[1:21 2:6] Changed	"exiting " to "forcing out "
[1:22 2:7] Changed	"Draining" to "[0017] Draining"

[1:22 2:7] Changed	"exiting " to "forcing out "
[1:23 2:8] Changed	"The" to "[0018] The"
[1:24 2:9] Changed	"The" to "[0019] The"
[1:25 2:10] Changed	"The" to "[0020] The"
[1:26 2:11] Changed	"Exiting " to "[0021] Forcing out "
[1:26 2:11] Changed	"with " to "while "
[1:27 2:12] Changed	"The method" to "[0022] The method"
[1:27 2:12] Changed	"providing dry gas" to "providing drying gas"
[1:27 2:12] Changed	"The dry gas" to "The drying gas"
[1:28 2:13] Changed	"Advantages" to "[0023] Advantages"
[1:30 2:15] Changed	"For" to "[0024] For"
[1:31 2:16] Changed	"Fig." to "[0025] Fig."
[1:32 2:17] Changed	"Fig. 2" to "[0026] Fig. 2"
[1:33 2:18] Changed	"Fig." to "[0027] Fig."
[1:35 2:20] Changed	"Reference" to "[0028] Reference"
[1:36 2:21] Changed	"A" to "[0029] A"
[1:37 2:22] Changed	"The apparatus" to "[0030] The apparatus"
[1:38 2:23] Changed	"The first" to "[0031] The first"
[1:38 2:23] Changed	"blottleneck" to "bottleneck"
[1:38 2:23] Changed	"have an inner ... than those" to "have larger ... diameters"
[1:38 2:23] Changed	"help " to "facilitate "
[1:39 2:24] Changed	"Through the first" to "[0032] Through the first"
[1:39 2:24] Changed	"10a pressurized" to "10a, pressurized"
[1:39 2:24] Changed	"and dry gas" to "and drying gas"
[1:39 2:24] Changed	"dry gas IPA( isoprophyl " to "drying gas, IPA (isopropyl "
[1:39 2:24] Changed	", for dry ... 125???.Through " to ". Through "
[1:39 2:24] Changed	"10b etching" to "10b, an etching"
[1:39 2:24] Changed	"10c cleaning" to "10c, cleaning"
[1:40 2:25] Changed	"The" to "[0033] The"
[1:41 2:26] Changed	"First," to "[0034] First,"
[1:42 2:27] Changed	"Next," to "[0035] Next,"
[1:42 2:27] Changed	"introduced ... process by " to "exposed to "
[1:42 2:27] Changed	"determined time." to "determined amount of time."
[1:43 2:28] Changed	"Next," to "[0036] Next,"
[1:43 2:28] Changed	"10a pressurized" to "10a, pressurized"
[1:43 2:28] Changed	"gas is pushed" to "gas are pushed"
[1:43 2:28] Changed	"exit " to "force out "
[1:43 2:28] Changed	"from the group consist" to "from a group consisting"
[1:43 2:28] Changed	"does " to "do "
[1:44 2:29] Changed	"Next," to "[0037] Next,"
[1:44 2:29] Changed	"objects and " to "objects, and then"
[1:45 2:30] Changed	"Next," to "[0038] Next,"
[1:45 2:30] Changed	"dry " to "the drying "
[1:46 2:31] Changed	"According" to "[0039] According"
[1:46 2:31] Changed	"does " to "do "
[1:46 2:31] Changed	"make " to "form "
[1:46 2:31] Changed	"exiting " to "forcing out of "

[1:46 2:31] Changed "through out " to "applied to "  
[1:46 2:31] Changed "also leads " to "results in "  
[1:47 2:31] Del Paras "What is claimed ... of the objects."



# APPARATUS FOR AND METHOD OF ETCHING AND CLEANING OBJECTS

## BACKGROUND OF THE INVENTION

### Field of the Invention

[0001] The present invention relates to an etching and cleaning apparatus and method for objects, and more particularly, to an apparatus and method for batch processes for objects such as a semiconductor wafer or a liquid crystal display (LCD) substrate.

### Description of Related Art

[0002] Etching technology is very important for compact and complicated substrates. Etching is followed by a cleaning process.

[0003] For a wet etching process a batch type process is usually adopted since it can provide mass production and a low production cost.

[0004] Fig. 1 schematically shows an etching apparatus of a batch type according to a conventional art.

[0005] A vessel 10 containing substrates 12 has upper and lower openings 111 and 113 and is linked by many pipes. To the upper opening 111 are linked a first supplying pipe 10a and a first draining pipe 10d and to the lower opening 113 are linked a second supplying pipe 10b, a third supplying pipe 10c and a second draining pipe 10e. The first supplying pipe 10a is for supplying IPA (isopropyl alcohol), the second supplying pipe 10b for supplying etching solution, and the third supplying pipe 10c for supplying D.I. (deionized) water. The first draining pipe 10d is for draining etching solution and D.I. water, and the second draining pipe 10e is for draining IPA and D.I. water.

[0006] The etching process and rinsing process using the apparatus is explained. First,

through the second and the third supplying pipes 10b and 10c, etching solution and D.I. water are supplied to the vessel 10 containing substrates 12, respectively. In some conditions only etching solution can be supplied, since D.I. water is for diluting the etching solution at this time.

[0007] Next, the substrates 12 are etched by the etching solution for some time.

[0008] Next, D.I. water is supplied through the third supplying pipe 10c so as to push the mixture of etching solution and D.I. water to the upper opening 111 for draining through the first draining pipe 10d. At this time D.I. water cleans the substrates 12.

[0009] Finally, D.I. water is drained through the second draining pipe 10e and IPA is supplied to the vessel 10 in order to dry the substrates 12.

[0010] However, referring to Fig. 2, during draining, the etching solution densities of the etching solution differ depending on the location of the interface of the etching solution and the D.I. water for cleaning. That is, in a certain instant during that process the density is high at the upper portion 12a of the vessel 10 and low at the middle portion 12b of the vessel, whereas at the lower portion 12c of the vessel 10 cleaning water such as D.I. water is filled. This density difference results in non-uniform etching of the substrate 12 depending on the position of the substrate 12.

[0011] During that time, while etching solution of high density is mixed with D.I. water for cleaning, an abnormal reaction such as an electric reaction occurs. When two metal layers on the substrate are etched in one process, some metals such as aluminum lose their electrons and some metals such as titanium receive the electrons. Donor metal is over etched, and the donee metal is etched less, which deteriorates the quality of etching.

### **SUMMARY OF THE INVENTION**

[0012] To overcome the problems described above preferred embodiments of the present invention provide an apparatus for and a method of etching and cleaning objects which can achieve uniform etching.

[0013] A preferred embodiment of the present invention provides an apparatus for etching and cleaning objects, including: a vessel having an upper opening and a lower opening; a first supplying pipe connected to the upper opening of the vessel, the first supplying pipe supplying dry gas; a second supplying pipe connected to the lower opening of the vessel, the second supplying pipe supplying etching solution; a third supplying pipe connected to the lower opening of the vessel, the third supplying pipe supplying cleaning solution; a first draining pipe connected to the upper opening of the vessel, the first draining pipe draining the cleaning solution; and a second draining pipe connected to the lower opening of the vessel, the second draining pipe draining the etching solution and the dry gas.

[0014] It is preferred that the second draining pipe is directly and straightly connected to the lower opening of the vessel and has a larger inner diameter than other pipes.

[0015] It is also preferred that in the second draining pipe a pump for draining etching solution is installed.

[0016] According to another aspect of the invention, the method of etching and cleaning objects contained in a vessel, includes: etching the objects by providing etching solution into the vessel; forcing out the etching solution from the vessel by providing pressurized gas into the vessel; cleaning the objects by providing cleaning solution into the vessel; and draining the cleaning solution from the vessel.

[0017] Draining the cleaning solution and forcing out etching solution are processed

through different draining pipes connected to the vessel.

[0018] The pressurized gas is preferably nitrogen gas.

[0019] The etching solution is preferably Oxalic acid solution or diluted Oxalic acid solution.

[0020] The cleaning solution is preferably deionized water.

[0021] Forcing out the etching solution is preferably done while pumping the etching solution out of the vessel.

[0022] The method may further include drying the objects by providing drying gas into the vessel after draining the cleaning solution. The drying gas may include IPA.

[0023] Advantages of the present invention will become more apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

[0024] For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following descriptions taken in conjunction with the accompanying drawings, in which like reference numerals denote like parts, and in which:

[0025] Fig. 1 is a schematic view of an apparatus for etching and cleaning objects according to a conventional art;

[0026] Fig. 2 is a similar view to Fig. 1, illustrating density difference in the vessel during the cleaning process while using the apparatus of Fig. 1; and

[0027] Fig. 3 is a schematic view of an apparatus for etching and cleaning objects

according to an embodiment of the invention.

### **DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS**

[0028] Reference will now be made in detail to preferred embodiments of the present invention, example of which is illustrated in the accompanying drawings.

[0029] A preferred embodiment of the present invention relates to a batch type apparatus for etching and cleaning the objects such as semiconductor wafers or substrates for LCDs.

[0030] The apparatus shown in Fig. 3 has a vessel 10 having upper and lower openings 110 and 112, which are connected to various pipes. The pipes connected to the upper opening 110 are a first supplying pipe 10a and a first draining pipe 10d, and the pipes connected to the lower opening 112 are second and third supplying pipes 10b and 10c and a second draining pipe 20. Though not illustrated in the drawings, there are valves in the pipes for selectively closing the pipes.

[0031] The first supplying pipe 10a is directly connected to the upper opening 110 of the vessel 10, and the first draining pipe 10d branches off from the main passage from the upper opening 110. The second draining pipe 20 is preferably straightly connected to the lower opening 112 of the vessel 10, and the second and third supplying pipes 10b and 10c branch off from the main passage from the lower opening 112 of the vessel 10. Since the second draining pipe 20 is straightly connected to the lower opening 112 of the vessel 10, draining through the second draining pipe 20 can be done without any bottleneck. The second draining pipe 20 can have larger inner diameter than inner diameters of other pipes, and have a pump "P" in order to facilitate easy draining.

[0032] Through the first supplying pipe 10a, pressurized gas and drying gas are supplied to the vessel 10. The pressurized gas needs to have a relatively low solubility to the



etching solution and can be nitrogen gas. For drying gas, IPA (isopropyl alcohol) can be used. Through the second supplying pipe 10b, an etching solution such as oxalic acid is supplied to the vessel 10. Through the third supplying pipe 10c, cleaning solution such as deionized water is supplied to the vessel 10.

[0033] The etching and cleaning process using the apparatus of the embodiment is explained.

[0034] First, through the second supplying pipe 10b etching solution is supplied to the vessel 10 having objects 12. At this time, in order to dilute the etching solution, cleaning solution such as D.I. water can be supplied to the vessel 10 at the same time.

[0035] Next, the objects are exposed to the etching solution for a determined amount of time.

[0036] Next, through the first supplying pipe 10a, pressurized gases such as nitrogen gas are pushed into the vessel in order to drain or force out the etching solution or the etching solution mixed with the diluting solution through the second draining pipe 20. At this time, the second draining pipe 20 is open and the pump "P" is operated for easy draining. The pressurized gas is preferably chosen from a group consisting of gases which do not react with the etching solution.

[0037] Next, the cleaning solution, for example D.I. water, is supplied into the vessel 10 through the third supplying pipe 10c in order to clean the objects, and then drained through the first draining pipe 10d.

[0038] Next, for the drying process, IPA gas is supplied through the first supplying pipe 10a and drained through the second draining pipe 20.

[0039] According to the embodiment of the invention, since the cleaning solution and the etching solution do not form any interface during forcing out of the etching solution, there

is no density difference of the etching solution applied to the objects during the process, which results in no electrical reaction during the process, leading to uniform etching for objects.